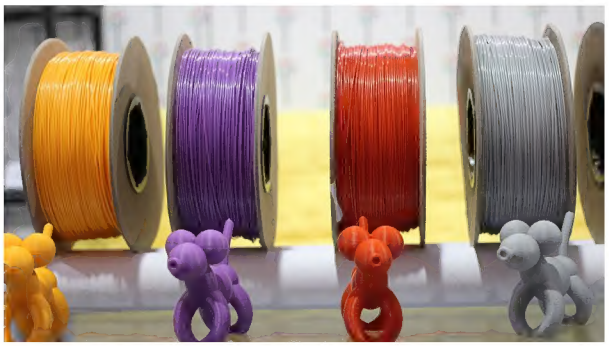
3D printing filament

3D printing filament is the thermoplastic feedstock for fused filament fabrication 3D printers. There are many types of filament available with different properties.[1]



3D printing filament in different colours with models created using the filament.

Filament comes in a range of diameters, most commonly 1.75 mm and 2.85 mm,[2] with the latter often being confused with the less common 3 mm. [3]

Filament consists of one continuous slender plastic thread spooled into a reel.[4]

Production

Commercially produced filament

Stacks of commercially produced filament which have been shrink-wrapped to protect the filament from moisture.

3D printing filament is created using a process of heating, extruding and cooling plastic to transform nurdles into the finished product. However, unlike a 3D printer, the filament is pulled rather than pushed through the nozzle to create the filament. The diameter of the filament is defined by the process that takes place after the plastic has been heated rather than the diameter of the extruder nozzle. A different force and speed is applied to the filament as it is pulled out of the extruder to define the width of the filament, most commonly 1.75 mm or 2.85 mm diameter.[5][6]

The plastic nurdles are always white or clear. Pigments or other additives are added to the material before it is melted to create coloured filament or filament with special properties, e.g. increased strength or magnetic properties. Before the filament is extruded the nurdles are heated to 80 °C to dry it and reduce water content. The nurdles must be dried as many thermoplastics are hygroscopic and extrusion of damp plastic causes dimensional flaws (this is also the case when the finished filament is being printed[7]). From there the nurdles are fed into a single screw extruder where it is heated and extruded into a filament.[5] The diameter is often measured by a laser beam(not melting) as part of a quality control mechanism to ensure correct diameter of the filament. The filament is then fed through a warm water tank which cools the filament which gives the filament its round shape. The filament is then fed through a cold water tank to cool it to room temperature. It is then wound onto a spool to create the finished product.[5]

DIY filament production

DIY filament production machines use the same method as FDM 3D printers of pushing the filament through the extruder to create the correct diameter filament. There are several DIY filament machines available as both open source plans and commercially available machines.

A food dehydrator can be used to remove water from hygroscopic materials at above 70 °C.[8]

Usage

The process of transforming 3D printing filament into a 3D model

1. The filament is fed into the FDM 3D printer.
2. The thermoplastic is heated past its glass transition temperature inside the hotend.
3. The filament is extruded and deposited by an extrusion head onto a build platform where it cools.
4. The process is continuous, building up layers to create the model.

Materials

Filament	Special Properties	Uses	Strength	Density (kg/m^3)	Flexi-bility	Dura-bility	Difficulty to print	Print Temperatur (°C)
PLA	Easy to print Biodegradable, though only in very specific conditions	Consumer Products	Medium	1240[9]	Low	Medium	Low	180–230
ABS	Durable Impact resistant	Functional Parts	Medium	1010[10]	Medium	High	Medium	210–250
PETG (XT, N-Vent)	More flexible than PLA or ABS Durable	All	Medium	1270[11]	High	High	Medium	220–235
PCTG	More flexible than PETG Durable	All	Medium	1230[12]	High	High	Medium	250–270
Nylon	Strong Flexible Durable	All	High	1020[13]	High	High	Medium	220–260
TPE	Extremely flexible Rubber-like	Elastic Parts Wearables	Low		High	Medium	High	225–235
TPU	Extremely flexible Rubber-like	Elastic Parts Wearables	Low		High	Medium	High	225–235
Wood	Wood-like finish	Home Decor	Medium	1400[14]	Medium	Medium	Medium	195–220
HIPS	Dissolvable	Support structures when using ABS on a dual extrusion printer.	Low	1040[15]	Medium	High	Medium	210–250
PVA	Dissolvable Water Soluble Biodegradable Oil Resistant	Support structures when using PLA or ABS on a dual extrusion printer.	High		Low	Medium	Low	180–230

Filament	Special Properties	Uses	Strength	Density (kg/m^3)	Flexi-bility	Dura-bility	Difficulty to print	Print Temperatur (°C)
PET (CEP)	Strong Flexible Durable Recyclable	All	High		High	High	Medium	220–250
PLA Metal	Metal Finish	Jewelry	Medium		Low	High	High	195–220
PLA Carbon Fiber	Rigid Stronger Than Pure PLA	Functional Parts	Medium		Low	High	Medium	195–220
Lignin (bioFila)	Biodegradable Stronger than PLA		Medium		Low	Medium	Low	190–225
Polycarbonate	Very strong Flexible Durable Transparent Heat Resistant	Functional Parts	High	1180 – 1200[16]	High	High	Medium	270–310
Conductive (usually a graphite-plastic blend)	Conductive	Electronics	Medium		Medium	Low	Low	215–230
Wax (MOLDLAY)	Melts Away	Lost wax Casting	Low		Low	Low	Low	170–180
PETT (T-Glase)	Strong Flexible Transparent Clear	Functional Parts	High		High	High	Medium	235–240
ASA	Rigid Durable Weather Resistant	Outdoor	Medium		Low	High	Medium	240–260
PP	Flexible Chemical Resistance	Flexible Components	Medium	1040[17]	High	Medium	High	210–230
POM, Acetal	Strong Rigid Low Friction	Functional Parts	High		Low	Medium	High	210–225

Filament	Special Properties	Uses	Strength	Density (kg/m^3)	Flexi-bility	Dura-bility	Difficulty to print	Print Temperatur (°C)
	Resilient							
PMMA, Acrylic	Rigid Durable Transparent Clear Impact Resistant	Light diffusers	Medium		Low	High	Medium	235–250
Sandstone (LAYBRICK; styled plastic)	Sandstone Finish	Architecture	Low		Low	Low	Medium	165–210
Glow-In-The-Dark plastic	Phosphorescence	Fun	Medium		Medium	Medium	Low	215
Cleaning	Cleaning	Unclogging of Nozzles	N/A		N/A	N/A	Low	150–260
PC-ABS	Rigid Durable Impact Resistant Resilient Deflecting Heat	Functional Parts	Medium		Low	High	High	260–280
Magnetic (PLA blend)	Magnetic	Fun	Medium		Medium	Medium	High	195–220
Color Changing (plastic blend)	Thermochromism	Fun	Medium		Medium	Medium	Low	215
nGen (co-polyester)	Similar to PETG Heat Resistant Transparent	All	Medium		High	High	Medium	210–240
TPC	Extremely Flexible Rubber-Like Chemical resistant Heat resistant UV light resistant	Elastic Parts Outdoor	Low		High	Medium	High	210
PORO-LAY	Partially Water Soluble	Experimental	Low		High	Medium	Low	220–235
FPE	Flexible	Flexible Parts	Low		High	High	Medium	205–250
PEI	Heat Resistant Strong	Functional Parts	High	1270	Medium	High	Medium	340–380

Filament	Special Properties	Uses	Strength	Density (kg/m^3)	Flexi-bility	Dura-bility	Difficulty to print	Print Temperatur (°C)
	Flame Performance							

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